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PSYCHOLOGICAL AND PHYSIOLOGICAL RESPONSES OF BLACKS AND CAUCASIANS TO HAND COOLING

U S ARMY RESEARCH INSTITUTE OF ENVIRONMENTAL MEDICINE

Natick, Massachusetts

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Tmf remained significantly ($P<0.05$, ANOVA for Race effects) higher in Caucasians compared to Blacks. Lower Tmf in Blacks may be a result of a greater sympathetic response to the cold water stress as noted by the HR, BP, and non-immersed BF values during the initial minutes of cold water immersion. SYS blood pressure increased 26 mmHg while BF in the non-immersed hand was reduced by 82% at minute 2, and HR increased by 16 beats/minute at minute 1 from baseline values in Blacks. These same responses in Caucasians were lower with mean changes in HR of 6 beats per minute ($P<0.01$), SYS of 19 mmHg ($P<0.05$), and a 73% reduction in BF. The data from this study support previous reports that peripheral cold sensitivity is greater in certain ethnic groups (Blacks) when compared to Caucasian individuals of similar age and physical characteristics. Another possible determinant of finger temperature during the cold water immersion test as demonstrated in this study was the level of prior cold weather experience (CE) an individual possessed. Sub-groupings were isolated within each racial group according to their prior CE as determined by questionnaire. Mean Tmf during the cold water immersion demonstrated an ordered ranking with Caucasian "MUCH" > Black "MUCH > Caucasian "MODERATE" > Caucasian "LITTLE" > Black MODERATE"> Black "LITTLE". Tmf was dependent on level of CE to a greater degree than geographic origin alone.

DISCLAIMER STATEMENT

The views, opinions, and/or findings contained in this report are those of the authors and should not be construed as official Department of the Army position, policy, or decision, unless so designated by other official documentation. In conducting the research described in this report, the investigators adhered to the AR 70-25 and USAMRDC Regulation 70-25 on Use of Volunteers in Research. Human subjects participated in these studies after giving their free and informed voluntary consent.

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Technical Report

PSYCHOLOGICAL AND PHYSIOLOGICAL RESPONSES OF BLACKS AND CAUCASIANS TO HAND COOLING

by

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ABSTRACT

It has been reported that as a ethnic group, Blacks demonstrate greater cold sensitivity than Caucasians and, therefore, are at greater risk for peripheral vascular cold injury, i.e., frostbite. The purpose of this investigation was to examine the physiological and psychological factors contributing to the susceptibility of Blacks and Caucasians to cold sensitivity. Control measurements were taken for 10 minutes in room air (RA) for 112 male subjects (52 Blacks and 60 Caucasians) between 18 and 41 years of age. Immediately following the control period, one hand was immersed for 20 minutes in 5°C, stirred cold water. Cardiovascular responses which included heart rate (HR, beats/minute), systolic blood pressure (SYS, mmHg), diastolic blood pressure (DIA, mmHg), mean arterial blood pressure (MAP, mmHg) and blood flow (BF, mls/100 ml/minute) in the immersed and non-immersed hands were monitored once every minute. Middle finger temperature (Tmf) of the immersed and non-immersed hands was measured every 30 seconds. Before cold water immersion, Tmf was higher (P<0.01) for Caucasians than Blacks with a mean±SEM of 30.7±0.45 and 28.4±0.58, respectively. During 20 minutes of cold water immersion, Tmf remained significantly (P<0.05, ANOVA for Race effects) higher in Caucasians compared to Blacks. Lower Tmf in Blacks may be a result of a greater sympathetic response to the cold water stress as noted by the HR, BP, and non-immersed BF values during the initial minutes of CW immersion. SYS blood pressure increased 26 mmHg while BF in the non-immersed hand was reduced by 82% at minute 2, and HR increased by 16 beats/minute at minute 1 from baseline values in Blacks. These same responses in Caucasians were lower with mean changes in HR of

6 beats per minute ($P<0.01$), SYS of 19 mmHg ($P<0.05$), and a 73% reduction in BF. The data from this study support previous reports that peripheral cold sensitivity is greater in certain ethnic groups (Blacks) when compared to Caucasian individuals of similar age and physical characteristics. Another possible determinant of finger temperature during the cold water immersion test as demonstrated in this study was the level of prior cold weather experience (CE) an individual possessed. Sub-groupings were isolated within each racial group according to their prior CE as determined by questionnaire. Mean Tmf during the cold water immersion demonstrated an ordered ranking with Caucasian "MUCH" > Black "MUCH" > Caucasian "MODERATE" > Caucasian "LITTLE" > Black "MODERATE" > Black "LITTLE". Tmf was depended on level of CE to a greater degree than geographic origin alone.

INTRODUCTION

A review of the literature suggests that Blacks demonstrate a different physiological response pattern to cold stress than Caucasians, thus raising the question of greater susceptibility in Blacks to cold injury (12,17,25). Medical records from the Korean War and Peace-Time maneuvers just after the Korean conflict revealed a much higher incidence of cold injuries among Black American soldiers than Caucasian (13,17). Although there were inordinate numbers of Blacks suffering from cold injuries, it was not known whether the reported data was biased by the proportion of representative groups actually exposed to cold. For example, if there were greater numbers of Blacks exposed to the cold conditions compared to Caucasians, then the number of cases of cold injuries would be prejudiced by disproportional representation. However, as suggested by Meehan (13), this may not be the case. He reported approximately 50% of the cold injuries inflicted during a 1954 Army field exercise in Alaska were experienced by Black soldiers who comprised only 10% of the total troops in the field. Additionally, Sumner et al. (24), who reviewed the predisposing factors of 292 frostbite cases over a three year period for soldiers stationed in Alaska, suggested that Black soldiers were approximately 3 times more susceptible to frostbite than Caucasians, regardless of rank, education or birthplace.

Physiological responses of Blacks to cold have been examined by a number of investigators (1,2,10,13,16,20,23,25). Baker (2) observed that a group of 17 Blacks had lower rectal and mean skin temperatures when compared to a group of 18 Caucasians of similar morphological

characteristics (height, weight, body fat%, etc.) after whole body cooling in air at 10°C, 50% RH and wind speed of 5 mph. He attributed the differences between groups to the relative distribution of body fat and also to the greater heat loss areas, i.e., longer arms, hands, fingers, etc. in Blacks, however, the differences reported were relatively small. Several investigators (10,16,20) have presented contradictory data showing that rectal and mean skin temperatures were not significantly different between Blacks and Caucasians after whole body cooling in ambient temperatures ranging from -12 to 17°C.

When hand cooling was examined without whole body cold exposure, Blacks, for the most part, demonstrated a totally divergent response pattern compared to Caucasians. Blacks exhibited faster cooling rates of extremities, lower peak finger temperatures and a slower rate of rewarming of hands (10,16). The attenuation or absence of cold-induced vasodilation or CIVD (vasodilation of the peripheral vasculature in response to cold) as proposed by Meehan (13) could explain the greater occurrence of peripheral tissue injury as previously noted in Blacks (17). Only one study to date reported finding no difference between Blacks and Caucasians in regards to the aforementioned parameters even when studied during different seasons of the year (23). In light of conflicting reports and a lack of conclusive evidence for increased cold sensitivity in Blacks compared to Caucasians, this study was designed to examine the psychological and physiological factors which may contribute to cold sensitivity in Blacks compared to Caucasians.

METHODS

Subjects:

A total of 112 subjects, 52 Black and 60 Caucasian males between 18 and 41 years of age, (24.8±6.05 and 23.1±4.98 yrs, mean±SD, Blacks and Caucasians, respectively) were utilized for this study. These were volunteers drawn from the hospital staff of Blanchfield Army Hospital, Ft. Campbell, Kentucky, Enterprise State Junior College, Enterprise, Alabama, the medical school of the University of Minnesota, Duluth, Minnesota and from military personnel at U.S. Army Research Institute of Environmental Medicine, Natick, MA. Data collection for this report was carried out over four consecutive years (1985 - 1988). All experiments were performed on subjects either during the late summer or early fall months so as to preclude recent cold weather exposure.

Prior to their participation, all subjects were briefed on the nature and purpose of the investigation. Individuals who volunteered were determined to be in good health by an attending physician, and they were required to sign the informed consent form as outlined by the guidelines of the USARIEM type protocol for Human Research (AR 70-25), and the Committee on the Use of Human Subjects in Research, University of Minnesota, Duluth, Duluth, Minnesota.

Eating, smoking and drinking, other than water, was prohibited for 2 hours prior to the study (7). Individuals who were taking certain medications or who had previous cold injuries or existing pathologies, i.e., Raynaud's disease, were excluded from the investigation. During the cold exposure each subject was clothed in a standard Army fatigue

uniform or its equivalent.

Procedures and Measures:

Prior to the start of the study a psychological profile was obtained by having each subject complete the State/Trait Anxiety Inventory, appendix 1, (22) and the Cold Environment Background Survey Form, appendix 3, (21). Certain questions taken from the Cold Background Survey Form were utilized to group individuals into according to their level of prior cold weather experience. This classification was used to factor out variables which were helpful in making predictions of individual reactions to cold stress.

Each subject was tested while seated in a room maintained between 23 and 25°C. After completion of questionnaire data, each subject was fitted with of ECG electrodes to record heart rate (HR) and electrocardiogram, T-type thermocouples for temperatures, plethysmographic finger blood flow cuff and strain gauge for finger blood flow (BF), and an automated sphygmomanometer for collection of systolic (SYS), diastolic (DIA) and mean arterial (MAP) blood pressure.

Pain Responsivity Test:

Sixty-five subjects (28 Blacks and 37 Whites) were used to test individual sensitivity to a standardized mechanical pain stimulus. The response to the mechanical pain responsivity test (PRT) was correlated to an individual's pain response produced by cold water hand immersion. Immediately following the prep period each subject was asked to undergo a PRT as described by Forgione and Barber (6). The pain stimulus

consists of the application of constant fixed pressure to the middle digit of the right middle finger. This procedure has been shown to be a reliable method for producing repeatable pain intensity measurements without causing tissue damage (15). The subject inserted his right middle finger in the pressure device's chute (Figure 1) which was adjusted to hold the subject's finger in order that a lucite edge would make contact with the middle digit of the finger. The lucite edge is 6mm in thickness and had been sanded to create a flat surface 3mm in width. A weight was attached to a lever 7 inches distal to the lucite edge which would act as a fulcrum generating a force of 2000 grams at the point of contact on the finger. The force generated was measured by a force transducer, Grass Instruments mdl. FT-10C, which was used in calibrating and monitoring the amount of force produced. At the time of contact of the edge with the subject's finger, a timer in full view of the subject was started. The subject was then instructed to rate the intensity of the pressure stimulus on a 0 to 10 point scale every 15 seconds for 2 minutes. The even numbers of the scale have the following verbal anchors: 0 = normal; 2 = uncomfortable; 4 = very uncomfortable; 6 = painful; 8 = very painful; and 10 = extremely painful. Physiologic responses, blood pressure and heart rate were collected, and the finger temperature of both hands were monitored continuously throughout the pressure stimulus test to correlate psychometric parameters of one stress (pain responsivity) with individual reactions to another stressor (cold).

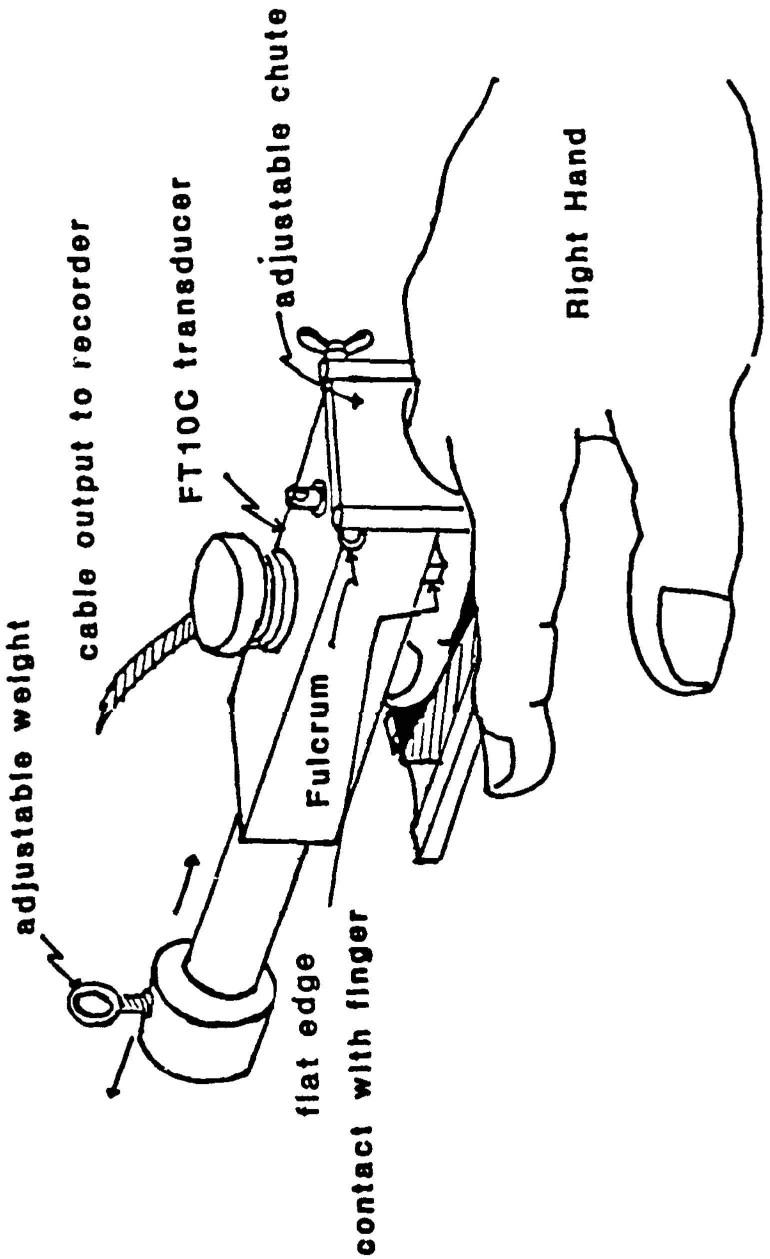

Figure 1. Pressure Stimulus Device

Control Measurements:

Immediately after the PRT, each subject placed both hands in a temperature controlled box held at an air temperature of 28-29°C for 10 minutes of baseline data collection. Since previous work in this laboratory suggested that the initial surface temperature of the hand would influence the response of the hand to cooling, holding the hand temperature at thermoneutral was believed to eliminate differences in the starting finger temperatures between subjects. However, this procedure was abandoned after completing the first 25 subjects and observing variable results for both groups. For the remainder of the study baseline data was collected while subjects hands remained in room air at heart level on a screened platform (so air could circulate around the fingers). HR, SYS, DIA, MAP, BF and finger temperatures were measured once a minute for 10 minutes.

Cold Water Test:

Immediately following baseline measurements, each subject immersed their left hand up to the wrist in stirred water held at 5°C. The immersed and non-immersed hands were kept in a position which was horizontal and at heart level of the seated subject. During the 20 minutes of the cold water test HR, BF, SYS, DIA, MAP and finger temperature (immersed and non-immersed hands) were measured. Subjects were asked to subjectively rate their perception of pain (according to the scale described above) and "coldness" of the water every minute. Cold sensation was based on the following scale: 0 = normal; 1 = cool; 2 = cold; 3 = very cold; 4 = extremely cold; and 5 = unbearably cold.

At the end of the 20 minutes of cold immersion all subjects removed their hand from the water. HR, SYS, DIA, MAP and finger temperatures were monitored while subjects held their right hand on a screened platform at heart level in room air for 15 minutes of recovery.

Statistical Analysis:

A repeated measures analysis of variance (ANOVA) was employed using a 2 factor (RACE by COLD EXPERIENCE Effects) design. Statistical significance was tested at the level of $P<0.05$. When significant differences were identified using ANOVA, Newman-Keuls Multiple Range test and Pearson's Product Correlation was used to isolate those variables which accounted for the greatest variability in the results.

RESULTS

The results of the pain responsivity test are shown in figure 2. Since pain intensity as rated by all subjects reached a plateau at approximately 60 seconds, the graph excludes the values beyond 60 seconds. Blacks rated their response to the constant pressure placed on the middle finger as higher ($P<0.05$) throughout the test compared to the group of Caucasian subjects. Higher pain intensity ratings by Blacks were associated with greater pre-state anxiety scores as measured by the State-Trait Anxiety Inventory questionnaire (Table 1). Pre-state anxiety scores were 35.8 ± 1.76 and 31.9 ± 1.09 for Blacks and Caucasians, respectively ($P<0.05$). Trait scores (a test for "how subjects generally feel") were not significantly different between groups. Post-state anxiety test values determined at the end of the experiment were equivalent for the two groups.

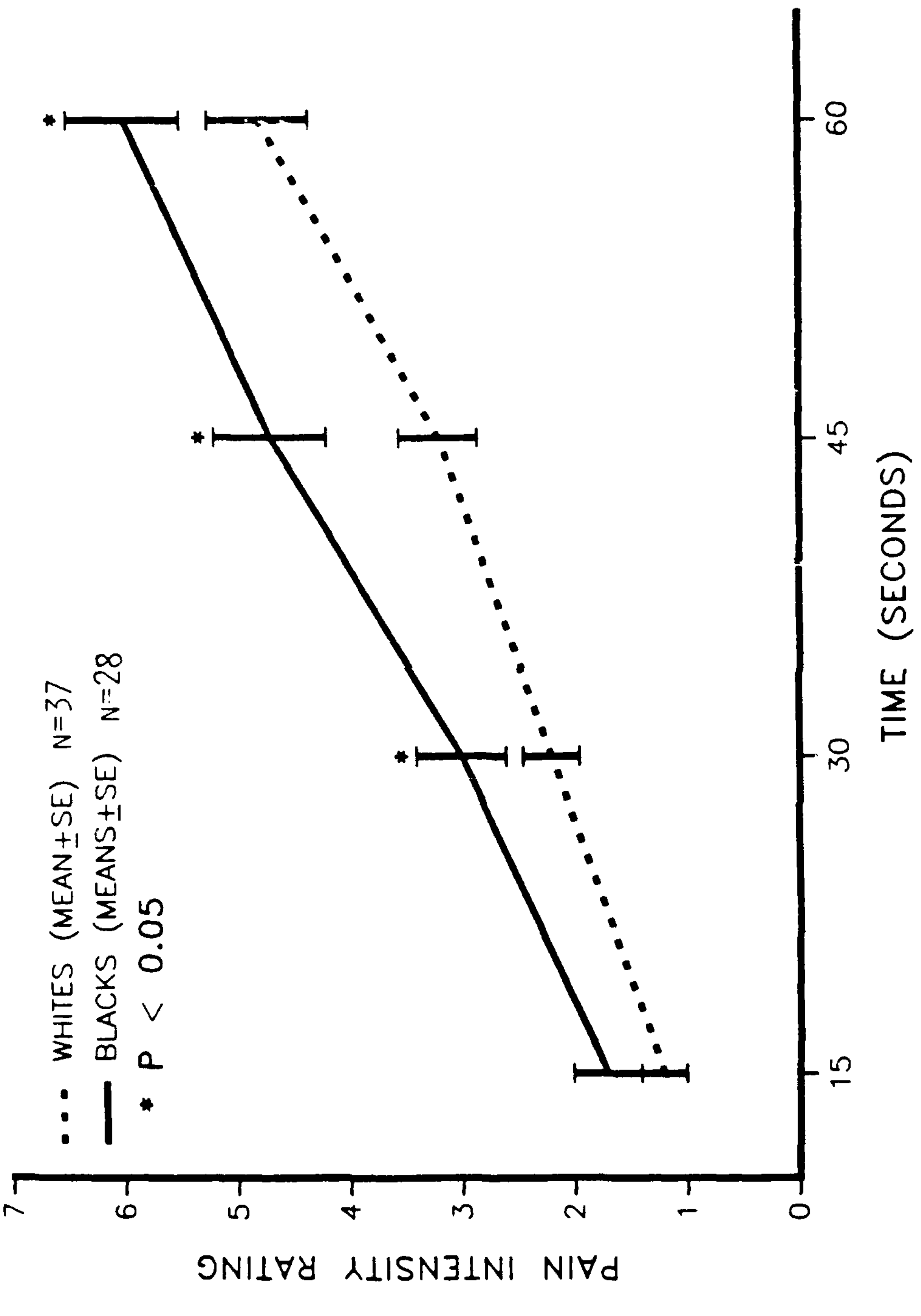

Figure 2. Pain Responsivity Ratings to a Constant Pressure.

TABLE 1

STATE - TRAIT ANXIETY SCORES

	n	PRE-STATE	POST-STATE	TRAIT
BLACKS	52	35.8±1.76*	32.0±2.43	32.5±1.54
CAUS	60	31.9±1.09	30.5±1.75	31.5±1.05

* $P<0.05$; data = mean±SEM

Thermal responses of Blacks and Caucasians are presented in Tables 2, 3 and 4 and figures 3, 4 and 5. The average middle finger temperature (Tmf) as listed in Table 2 for Caucasians during baseline measurements was 2.4 degrees C higher than that for Blacks ($P<0.01$). Throughout the cold water cold water immersion, mean Tmf in both the immersed and non-immersed hands was lower in Blacks compared to Caucasians (figures 3 and 4). The greatest difference (mean) between groups for immersed Tmf during the cold water test was 1.7° C (Caucasian Tmf higher than Black Tmf). Upon cold water immersion Caucasians exhibited a greater ($P<0.05$) drop in Tmf by the second minute than Blacks. Immersed Tmf in Caucasians decreased 22.5° C from baseline values compared to a 19.9° C reduction in immersed Tmf in Blacks. The lowest Tmf (mean±SEM) obtained was 5.7±0.08 and 6.5±0.12 for Blacks and Caucasians ($P<0.001$), respectively, and it required only 4.2 minutes for Whites compared to 6.6 minutes for Blacks to reach this nadir. This may indicate a more reactive vasculature in the Caucasian subjects than Blacks.

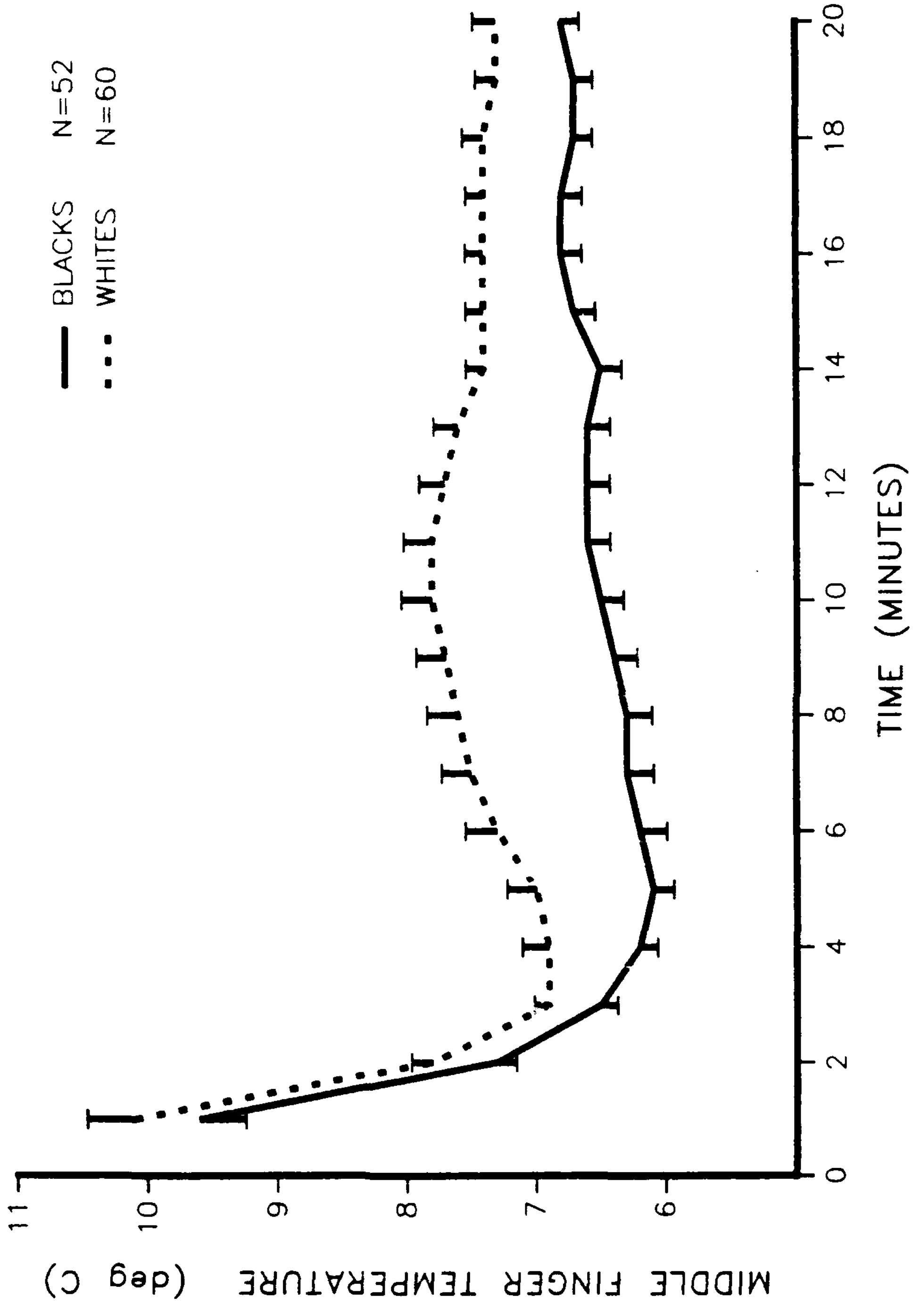

Figure 3. Finger Temperatures During Cold Water Immersion as Related to Race.

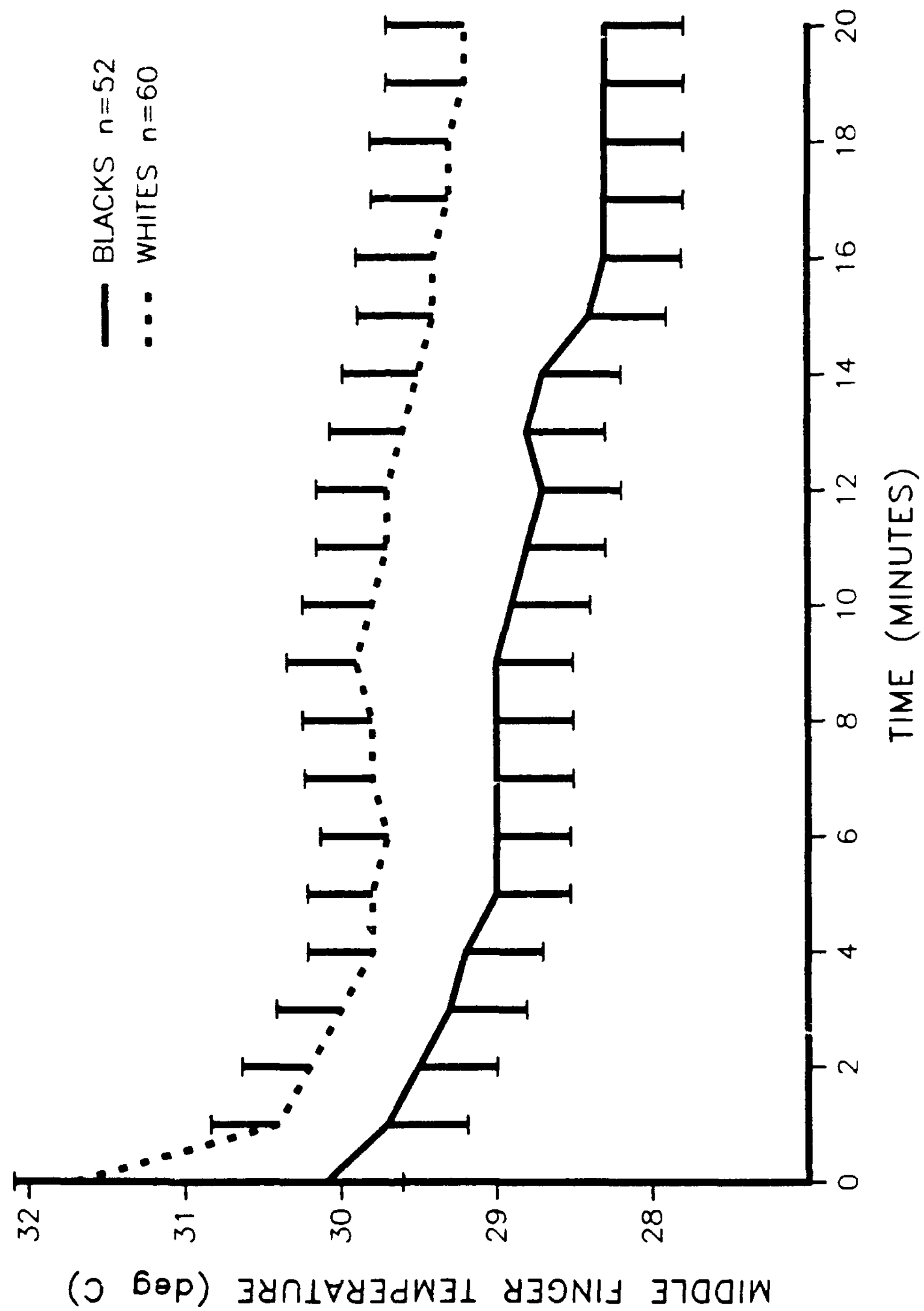

Figure 4. Finger Temperatures of the Non-immersed Hand During Cold Immersionas Related to Race.

TABLE 2

COMPARISON OF RESULTS ON FINGER TEMPERATURE RESPONSES

	BLACKS n = 52	CAUCASIANS n = 60
PRE-IMMERSION Tmf (° C)	28.4±0.5 (21.7 - 34.8)	30.8±0.5 ** (23.2 - 35.7)
LOWEST Tmf (° C)	5.7±0.1 (4.8 - 8.4)	6.5±0.1 ** (5.1 - 8.2)
TIME TO LOWEST Tmf (mins)	6.6±0.5 (2.5 - 18.0)	4.2±0.2 ** (1.0 - 17.0)
TIME TO FIRST REWARMING (mins)	11.2±0.8 (3.5 - 18.0)	8.2±0.5 ** (3.5 - 16.0)
PEAK REWARMING TEMPERATURE (° C)	8.5±0.3 (7.0 - 11.2)	9.5±0.3 * (7.0 - 16.1)
MEAN FINGER TEMPERATURE DURING IMMERSION (° C)	6.8±0.1 (5.3 - 10.1)	7.6±0.2 ** (5.6 - 11.4)

Values are means±SEM; Tmf = Middle Finger Temperature
* $P<0.05$; ** $P<0.01$

Since individual thermal responses were quite variable during the cold immersion, another procedure, area under the cooling curve, was utilized to make standardized comparisons across groups. Table 3 presents the comparisons for cooling areas for Blacks and Caucasians. The areas (mean±SEM) were 138±3.24 and 155±3.34 for Blacks and Caucasians, respectively ($P<0.001$). When the best and worst responders for Blacks are compared with the best and worst responders for Caucasians (Table 3), Caucasians again demonstrated significantly higher ($P<0.001$) values for area under the cooling curves.

TABLE 3

COMPARISON OF COOLING AREAS[a] BY RACE

GROUP	n	AREA±SEM	RANGE	PROBABILITY
TOTAL BLKS	51	138±3	(104 - 205)	<0.001
TOTAL CAUS	59	155±3	(106 - 230)	
HI[b] BLKS	30	153±3	(130 - 205)	<0.001
HI CAUS	30	173±3	(152 - 230)	
LOW[c] BLKS	20	117±2	(104 - 129)	<0.001
LOW CAUS	20	130±3	(106 - 146)	

[a]AREA = Area under the middle finger cooling curve
[b]HI = 30 Best responders
[c]LOW = 20 Worst responders

Individual thermal responses (CIVD) are presented in Table 4.

TABLE 4

COLD INDUCED VASODILATION[a] DATA FOR BLACKS AND CAUCASIANS

	BLACKS (n = 52)	CAUCASIANS (n = 60)
SUBJECTS WITH CIVD	26 (50%)	36 (58%)
CIVD ONSET (mins)	11.5±0.8 * (3.5 - 18.0)	8.2±0.6 (3.5 - 16.0)
CIVD AMPLITUDE (° C)	2.9±0.2 (1.5 - 5.8)	2.9±0.2 (1.5 - 8.5)
PEAK TIME CIVD (mins)	13.3±0.8 * (3.5 - 18.0)	10.3±0.7 (4.0 - 18.0)

Values are means±SEM; * P<0.05; [a](an increase in Tmf of 1.5 °C from the lowest Tmf)

There were more Caucasian subjects who displayed CIVD's compared to Blacks (CIVD criterion = an increase in Tmf of 1.5° C above the lowest Tmf). Twenty-six of 52 or 50% of the Blacks compared to 35 of 60 or 58% of the Caucasians demonstrated CIVD's. The average peak Tmf was 8.5 and 9.5° C for Blacks and Caucasians, respectively, which was significant at $P<0.01$. Average onset time for first rewarming (CIVD) was significantly greater ($P<0.01$) for black subjects than Caucasians (11.2 and 8.2 minutes, respectively).

Finger temperature during the cold water immersion was strongly influenced by the level of prior cold weather experience of the individual. Tmf was more a function of the amount of cold experience and not related to the geographic background of the individual. The data in figure 5 illustrate this point. When Tmf is plotted over the cold water immersion as function of cold experience, which is classified into 3 categories ("little", "moderate" and "much" by the scheme outlined in appendix 2 it was noted that there exists a family of temperature response curves. The curve depicting data from the "moderate" CE groupings is equivalent to the overall mean data plotted for all the Blacks compared to all of the Caucasians (figure 3). Those individuals with "much" CE have mean data curves which lie higher than the "moderate" CE groups, and those subjects with "little" CE show mean data curves which fall below that of the "moderate" CE groups. Pearson's Product Correlation (Table 5) showed a much higher potential for predicting finger temperature for a given time interval throughout the cold water immersion by using the level of cold experience of the individual than by using origin of the individual by itself.

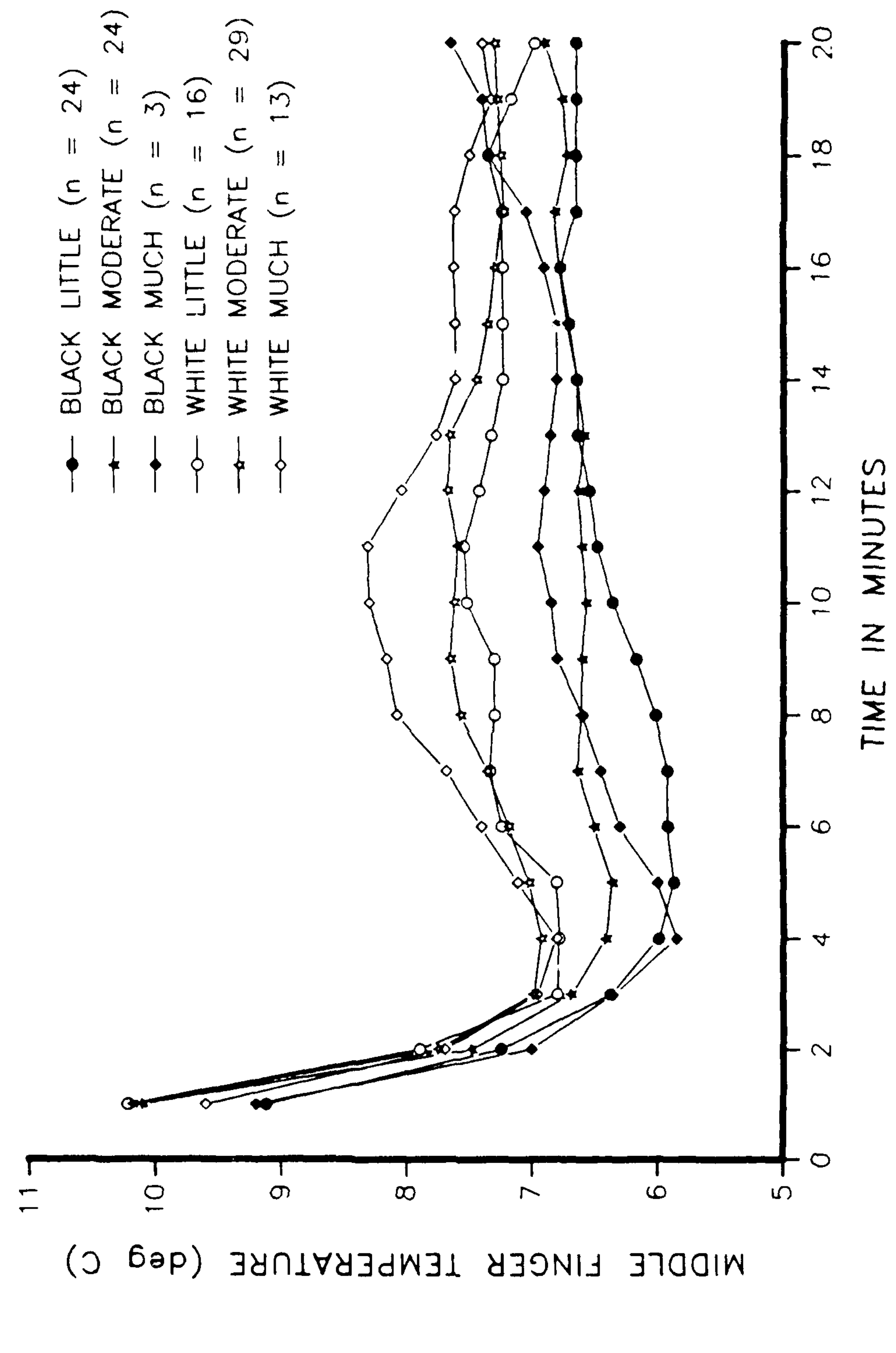

Figure 5. Finger Temperatures During Cold Water Immersion as Related to Cold Experience.

TABLE 5

CORRELATION COEFFICIENTS ON FACTORS
INFLUENCING FINGER TEMPERATURE

PARAMETER	FACTORS RACE	ORIGIN	COLDEXP *
Tmf PRE-IMMERSION	.28 p = .004	-.002 p = .492	-.005 p = .478
Tmf 1 MINUTE IMMERSION	.085 p = .185	-.009 p = .465	.032 p = .369
Tmf 2 MINUTE IMMERSION	.182 p = .027	-.064 p = .252	.031 p = .372
Tmf 3 MINUTE IMMERSION	.216 p = .011	-.026 p = .394	.143 p = .067
Tmf 6 MINUTE IMMERSION	.293 p = .001	.020 p = .417	.146 p = .067
Tmf 10 MINUTE IMMERSION	.375 p = .000	.003 p = .489	.214 p = .012
Tmf 15 MINUTE IMMERSION	.286 p = .001	.143 p = .066	.142 p = .068
Tmf 20 MINUTE IMMERSION	.169 p = .038	.044 p = .321	.176 p = .032

p = 1 - Tailed Probability; * COLDEXPER = Cold Experience as determined by appendix 2.

The temperature data suggests that several sub-groupings existed within our groups of Black and Caucasian subjects. Each subgroup displayed a different set of temperature response patterns which may be based on factors other than racial background. The cross-tabulations presented in Tables 6 and 7 below clarify this point.

When the subjects were divided into categories based on their place of origin (Table 6), there were approximately 53% of Caucasians compared to 31% of Blacks who came from Cold/Cool region states, whereas

69% of the Blacks compared to 47% of the Caucasians originated from Mild/Warm region states. This distribution is significantly different (P<0.02) as analyzed with a Chi-square distribution test.

TABLE 6

CROSS-TABULATION OF RACE BY ORIGIN *

		ORIGIN				
		COLD	COOL	MILD	WARM	Row Total
RACE	BLACK	9	7	20	16	52 46.4%
	WHITE	16	16	9	19	60 53.6%
	Column	25	23	29	35	112
	Total	22.3	20.5	25.9	31.3	100.0%

* Ratings of Origin based on appendix 3. Cold = states from Zone 1; Cool = states from Zone 2; Mild = states from Zone 3; Warm = states from Zone 4 (refer to appendix 4).

In Table 7 all individuals are classified according to their prior cold weather experience. Approximately 70% of the Caucasian subjects were classified under "moderate" and "much" CE categories compared to approximately 54% of the black subjects. There were 13 Caucasians with "much" CE but only three black subjects with "much" CE, however, this could be expected due to the greater percentage of Caucasians from COLD/COOL regions.. This distribution by race was significantly different (P<0.01) as tested by a Chi square distribution test.

TABLE 7

CROSS-TABULATION OF RACE BY COLD EXPERIENCE*

		COLD EXPERIENCE			Row
		Little	Moderate	Much	Total
RACE	BLACK	24	25	3	52
					46.4%
	WHITE	18	29	13	60
					55.7%
	COLUMN	42	54	16	112
	TOTAL	37.5	48.2	14.3	100.0%

*Ratings of Cold Experience based on appendices 2, 3 and 4.

Table 8 presents a breakdown of "High" and "Low" responders from each group across ORIGIN and COLD EXPERIENCE factors. "High" responders are those individuals who maintained a mean finger temperature during the cold test equal to or greater than the population mean plus 1 Standard Deviation (SD). The "Low" responders have a value equal to or less than the population mean minus 1 SD. As depicted in Table 8 Black and Caucasian "Low" responders lack individuals under the category of "MUCH" cold experience whereas some of these individuals originated from cold or cool climate regions. It should be noted that there exists an unequal distribution of RACE across "High" and "Low" responders. Caucasians were characterized as having greater number of subjects in the "High" classification and Blacks showed a larger number of "Low"

responders.

TABLE 8

BREAKDOWN OF HIGH AND LOW RESPONDERS BY RACE, ORIGIN AND COLD EXPERIENCE

	n	ORIGIN 1	2	3	4	COLD EXPERIENCE 1	2	3
LOW[a] BLKS	15	4	2	3	6	5	10	0
LOW CAUS	4	2	0	2	0	1	3	1
HIGH[b] BLKS	3	0	2	1	0	0	2	1
HIGH CAUS	15	1	8	2	4	3	7	5

[a] LOW denotes responders whose mean finger temperature during the cold test was $\leq$ than the population mean - SD ($\leq$ 6.09 ° C)
[b] HIGH denotes responders whose mean finger temperature during the cold test was $\geq$ than the population mean + SD ($\geq$ 8.35 ° C)
ORIGIN and COLD EXPERIENCE refer to appendices 2, 3 and 4.

Mean values (figure 6) for baseline BF (mls/100 ml/minute) in Caucasians were greater than Blacks (38.8 and 33.2, respectively), but the difference was not significant due to the large intra-subject variability. BF in the immersed hand decreased 78% from baseline in Caucasians compared to a 81% reduction in Blacks with 2 minutes of cold water immersion. BF recovered somewhat in Blacks but to a greater extent in Caucasians for the remainder of the cold water immersion. The cold water immersion seemed more stressful for the Black subjects overall as indicated by the non-immersed BF values. BF in the non-immersed hand decreased 80% in Blacks compared to 73% in Caucasians These responses may signify a greater general sympathetic output in the Blacks to the cold stress which is evidenced also by the heart rate, blood pressure and psychological data.

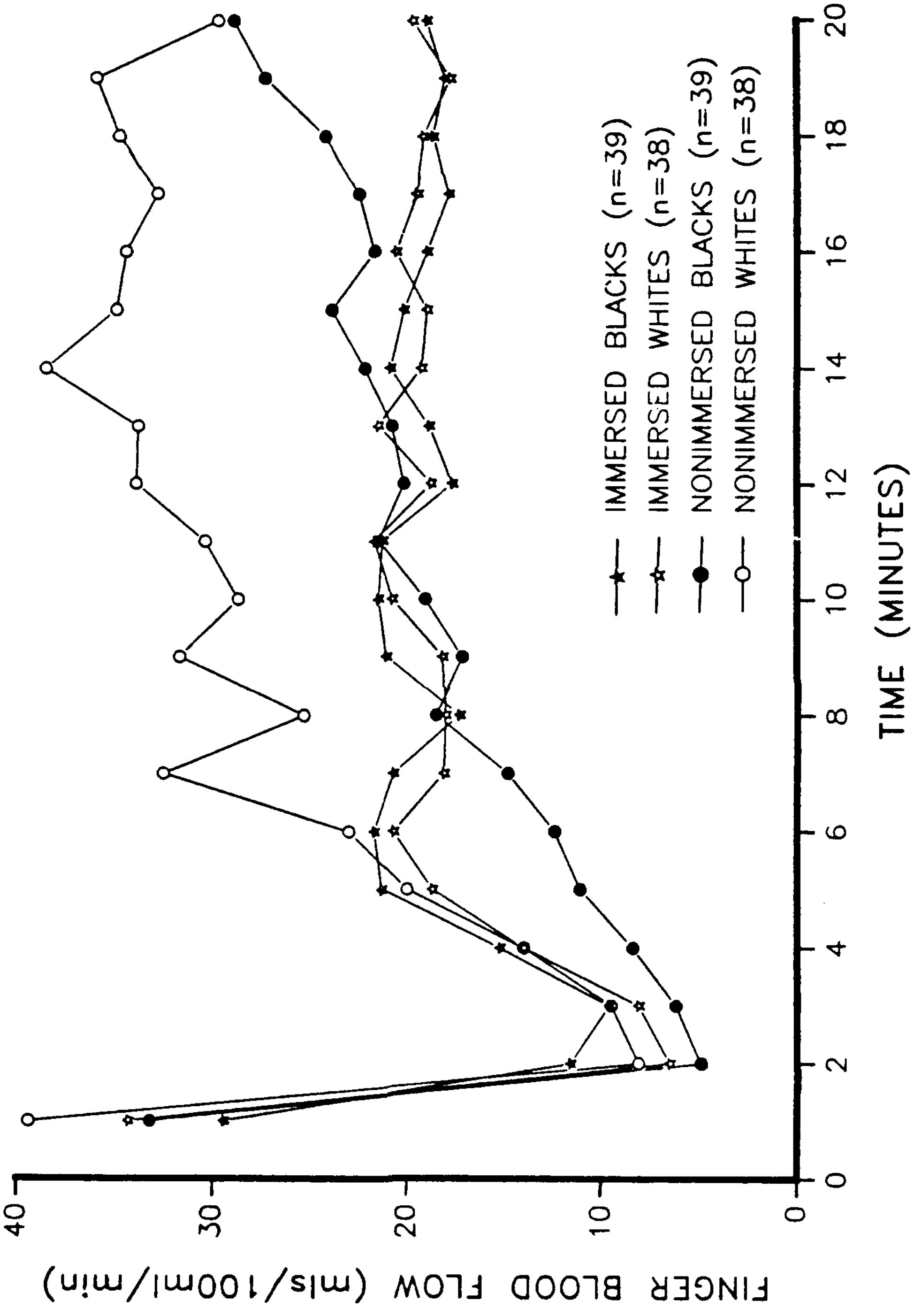

Figure 6. Blood Flow Responses During 20 Minutes of Cold Water Immersion

Heart rate (Figure 7) increased significantly in Blacks and Caucasians from baseline values with cold immersion. Although both groups exhibited a recovery of HR to pre-immersion values by the fourth minute of cold water immersion, significant differences existed between Blacks and Caucasians. As shown in Figure 7, HR increased an average of 16.8 beats/minute in the group of Blacks for the first minute ($P<0.01$) compared to baseline. One minute cold water immersion HR values for Caucasians were significantly greater ($P<0.05$) than baseline but recovered to baseline values by the third minute of immersion. HR in Blacks was lower ($P<0.05$) by the end of the cold test than HR in Caucasians.

After cold water immersion, blood pressure (Figure 8) significantly increased in each group above baseline values. The rise in systolic (SYS) in Blacks, especially in the initial minutes of cold water immersion, was greater than in Caucasian subjects. SYS blood pressure was only significantly different at the second minute of cold water immersion (figure 8) with mean$\pm$SEM values of 152 ± 3.6 and 145 ± 2.7 mmHg for Blacks and Caucasians, respectively, ($P<0.05$). After the third minute of cold water immersion, SYS and MAP displayed a slow recovery towards pre-immersion values but was significantly higher than baseline for both Blacks and Caucasians throughout the cold stress. Black subjects showed lower SYS and MAP values at the end of the CW test with only the 20 minute SYS value being significantly lower ($P<0.05$) than Caucasians. Diastolic blood pressure (DIA) was significantly elevated upon cold water immersion and remained significantly higher than baseline values throughout the cold test, but there were no differences

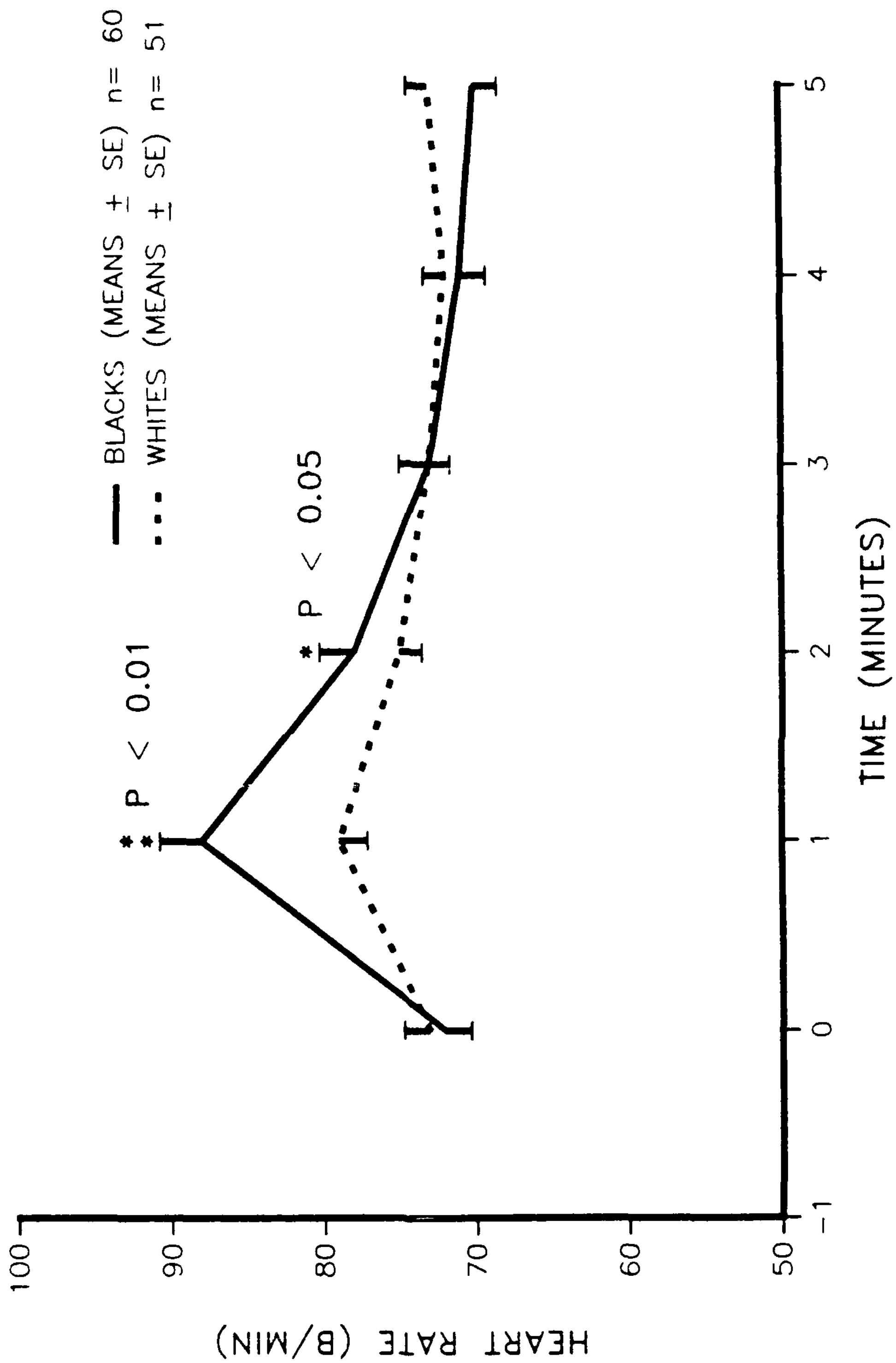

Figure 7. Heart Rate Responses in the First 5 Minutes to Cold Water Immersion.

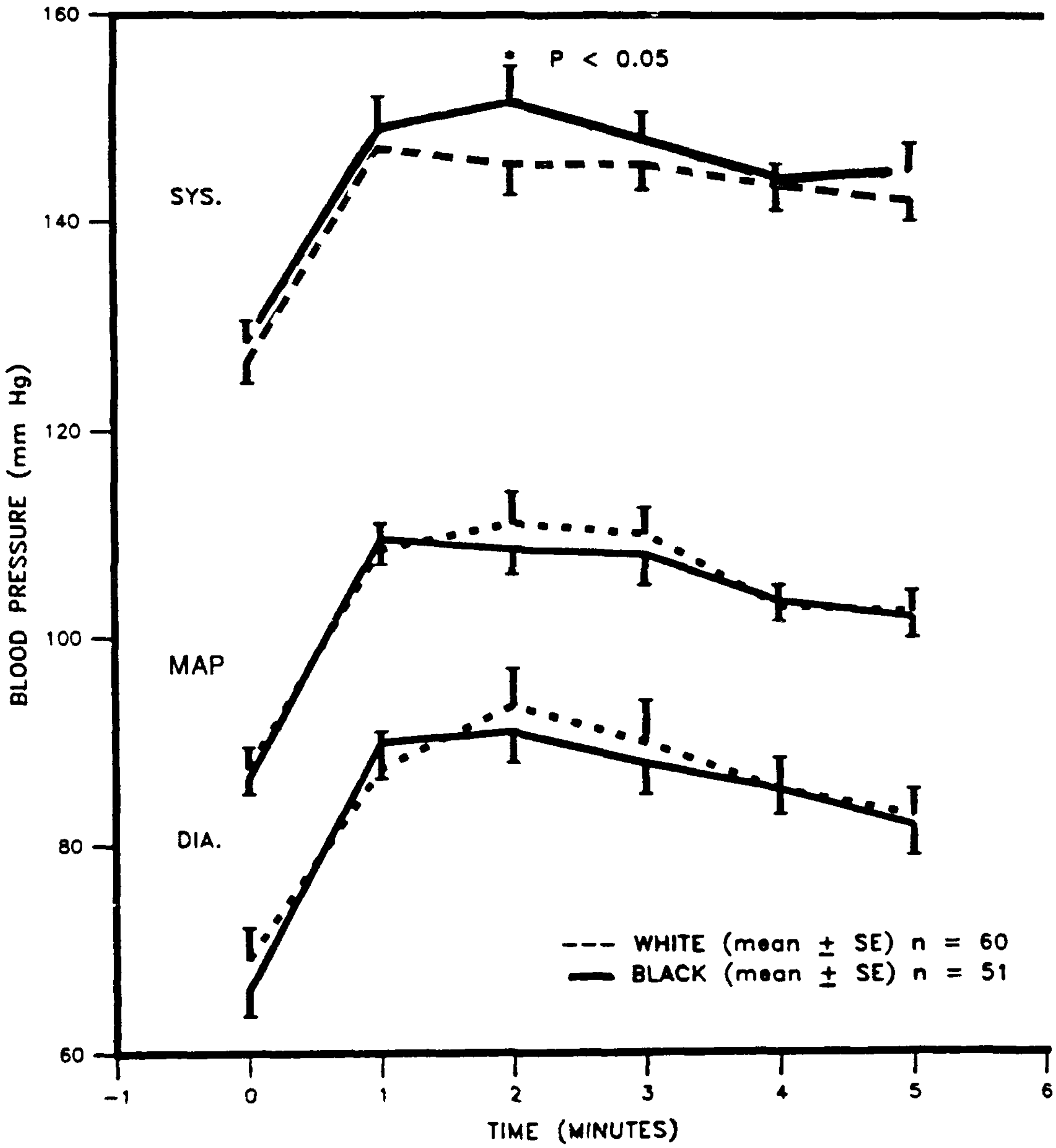

Figure 8. Blood Pressure Responses in the First 5 Minutes to Cold Water Immersion.

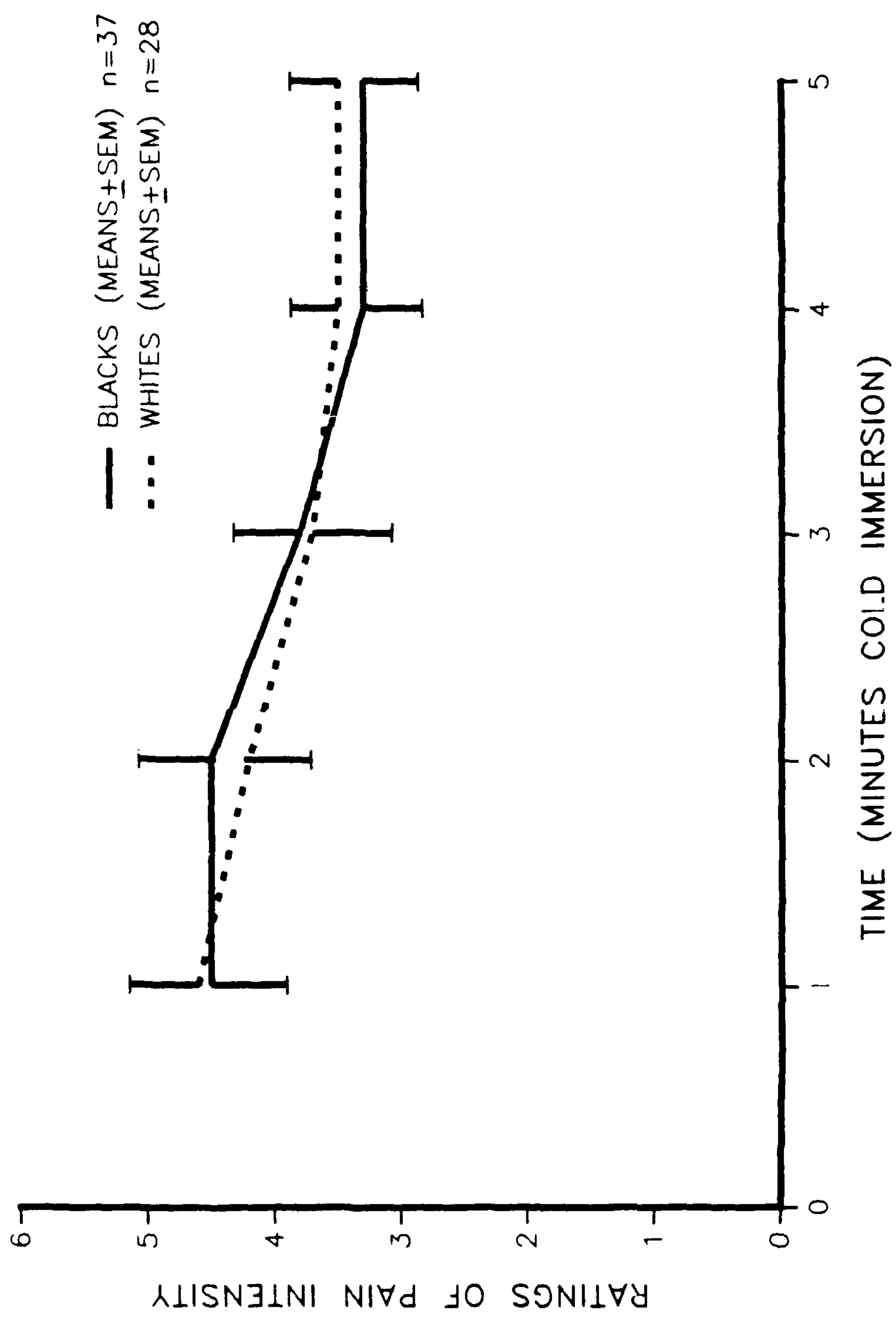

Figure 9. Rating of Pain Intensity During 5 Minutes of Cold Water Immersion.

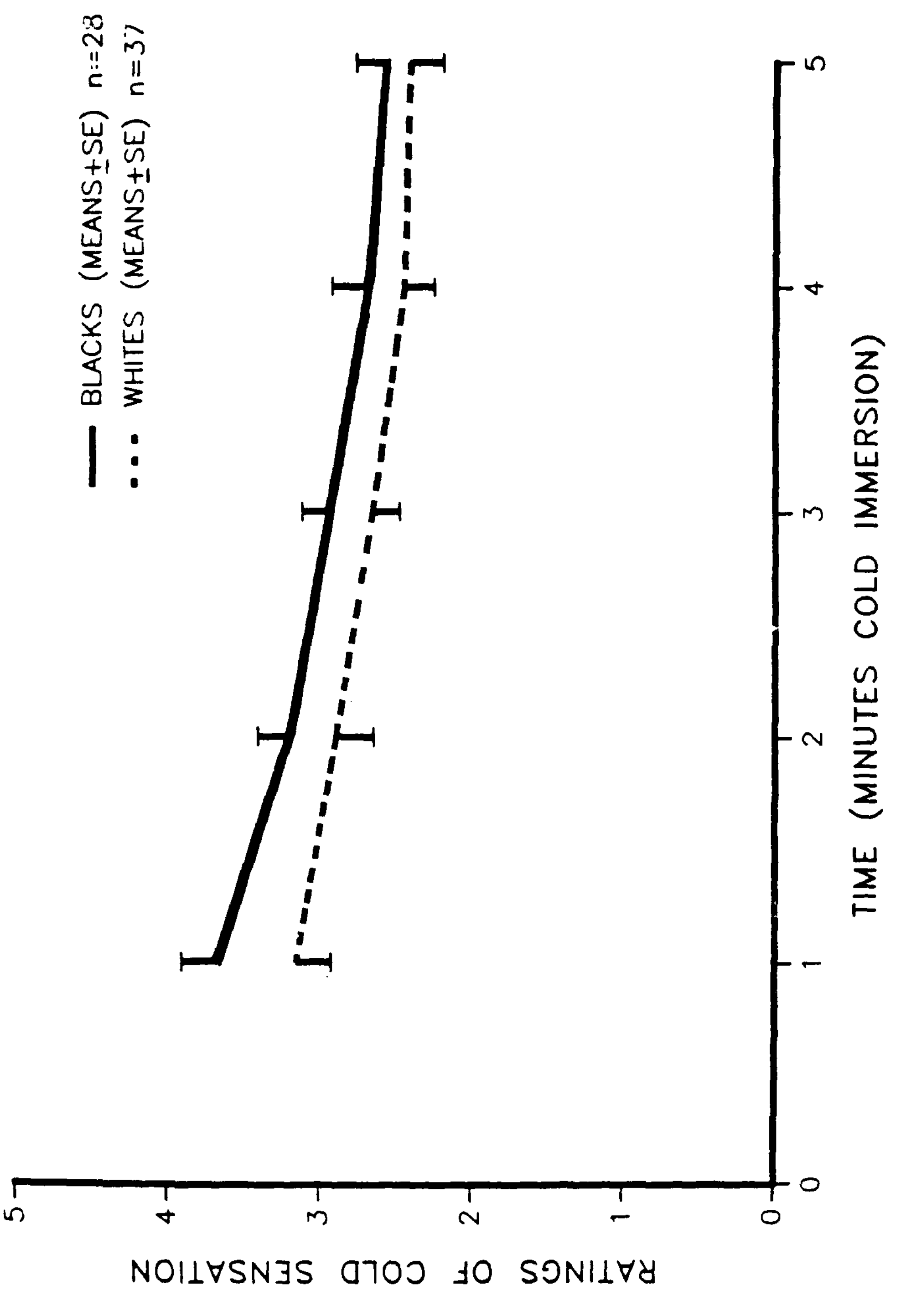

Figure 10. Rating of Cold Sensation During 5 Minutes of Cold Water Immersion.

for DIA values between groups.

Subjective ratings of pain intensity (PI) and cold sensation (CS) during the first 5 minutes of the cold water immersion were collected on 37 and 28 Caucasians and Blacks and are shown in figure 9 and 10. CS and PI ratings increased sharply with cold water immersion and leveled off by the third minute of the cold test. The Black subjects tended to rate the cold as more stressful but the ratings of (PI) and (CS) were not significantly different between groups.

DISCUSSION:

It has been reported in earlier studies that Black males may have a different "physiological" thermoregulatory set point than Caucasians males (25). These reports are supported by the Tmfs recorded in this study during baseline measurements. In room air, Black subjects exhibited finger temperatures which were 2-3°C lower than the Caucasian subjects tested. This data agree with previous findings of Wyndham et al. (25) who measured whole body and hand temperature responses of European Caucasians and of Black African miners to varying ambient air temperatures ranging from 5 to 27°C. These authors found that finger temperature responses for Black Africans and European Caucasians were similar when exposed to 5°C air temperature but that at 27°C ambient temperature Caucasian finger temperatures were 2-3°C higher than Blacks. Therefore, what is perceived as thermoneutral or even comfortable air temperatures may be different for Blacks when compared to a group of Caucasian males (25). It is also reported that patients who demonstrated "cold sensitivity" exhibited finger temperatures which are significantly lower at room temperature than normally non-cold sensitive subjects (16,

20).

Black subjects in this study responded to the cold stress differently as evidenced by the cardiovascular data. Both heart rate and blood pressure during the initial minutes of the cold stress were significantly higher in the Black individuals. These responses as well as the reaction of the finger blood flow in the non-immersed hand of Black subjects suggest a greater sympathetic output during the cold stress for Blacks. It is well known that the temperature of the hand is dependent upon the blood flow to the hand. If Black subjects demonstrated a greater sympathetic response to the cold stress, a greater degree of vasoconstriction (lower blood flow) would account for the lower Tmf observed in Blacks.

Ottson (18) reports that Black males and females demonstrate a similar threshold but that their tolerance to pain is lower compared to Caucasian males. Threshold to pain is defined as stimulus strength at which the subject perceives the stimulation as being painful. Tolerance is defined as the stimulus strength at which the subject will no longer accept a stronger stimulus. In this study the results of constant pressure stimulus delivered to the finger was rated at a greater pain intensity level by the group of Black subjects compared to the Caucasians. Brown, Fader and Barber (4) found that patients rated pain intensity perceived from immersing their hands in ice water as equivalent to pain they sensed from a pressure stimulus to the finger. Consequently, we anticipated finding a strong correlation between subjects' ratings of cold pain and pressure induced pain in this study. Accordingly, the Blacks should have perceived the cold water immersion

as more stressful. Verbal ratings of cold pain should have correlated with the physiological reactions observed in Blacks with cold water immersion. Although Blacks rated the pressure stimulus as more painful, PI and CS ratings were similar for the two groups during the CW immersion.

The literature is replete with studies that suggest a cold acclimatization with repeated cold exposures. However, no one has been able to prove that long term physiological acclimatization to cold in man exists. It is more likely that man habituates to cold, that is, he becomes accustomed to the cold stress with repeated exposures. For example, it is a common observation of many of us who after a short period of exposure to winter cold, find that an equivalent temperature in December will not be perceived the same way in the month of March. That is, a day found uncomfortably cold in the initial months of winter, is not as harsh after being habituated to cold. It is generally believed that those who are well-habituated to cold will perform better in the cold. This suggests that performance in the cold may be more a function of psychological than a physical habituation.

The notion of acclimating to the cold is exploited by the Russian Army (3). Massive numbers of Russian troops are stationed in areas where sub-Arctic temperatures are encountered for extended periods of the year. In comparison, the American Army has only a small percentage of its soldiers in these latitudes. The typical Russian soldier when sent to these climes, is systematically "toughened up" to better withstand the severely cold environments encountered. Slow deliberate programs are utilized to habituate Russian soldiers to cold by exposures

to increasingly colder stresses (cold water showers).

Leblanc (12) has reported an improved tolerance to pain after repeated cold water hand immersion. It is not fully understood, but the process of repeated cold exposures is effective in reducing the vasospastic episodes of Raynaud's patients. When exposed to even cool ambient temperature, Raynaud patients undergo an intense vasoconstrictive attack of their peripheral circulation. Pavlovian or operant conditioning (repeated treatments of the unconditioned stimulus, warm water hand immersions, coupled with the conditioned stimulus, cold air whole body exposures) significantly reduces the vasoconstrictive episodes in these patients when exposed to cold alone (11). These observations suggest that the central nervous system may play an important role in the cold acclimation process. A reduction in the sympathetic tone may be involved in the habituation to cold in normal individuals or in the reconditioning of the Raynaud's patients.

In our study there were a greater number of caucasian subjects who had "much" cold experience than Blacks (see Table 7). Therefore, lower mean finger temperatures observed in Blacks may have been more a function of this group having a lessor amount of cold weather experience compared to the Caucasian subjects. Under the conditions as presented in this investigation, hand temperature for the group of Blacks who had lower overall cold experience (as determined by our classification) was different than the group of Caucasians. This suggests that other factors working in conjunction with race may be responsible for peripheral vascular cold sensitivity in certain individuals.

CONCLUSIONS:

In this investigation Black subjects exhibited lower mean finger temperatures than Caucasian subjects during the cold exposure. One of the underlying determinants of finger temperature response as suggested by the data may be the level of prior cold weather experience. During the cold stress Tmf demonstrated a correlation with level of prior cold weather experience which affected peripheral vascular response greater than geographic origin alone. In this study, there was a greater number of Caucasians with "much" cold experience compared to Blacks. Accordingly, finger temperature response was lower during the cold exposure in Blacks compared to Caucasians which may be due to the amount of group cold experience. A follow-up investigation is proposed to determine how much cold experience (short term, months of exposure, or long term, multi-generational or 2-3 family generations) is required to influence an individual's ability to maintain hand temperature in cold.

SUMMARY:

1. The findings indicate that the group of Blacks (n= 52) in this study demonstrated significantly lower finger temperatures than Caucasians (n= 60) when faced with an equivalent cold stress (hand immersed in 5° C water for 20 minutes). Caucasians showed lower heart rate, systolic blood pressure and finger blood flow decrements indicating a reduced sympathetic (vasoconstrictive) response to the cold stress compared to

Blacks.

2. A relationship is suggested for finger temperature during the cold exposure and level of cold experience. The group of Blacks in this study who exhibited a lower overall amount of cold experience also demonstrated lower finger temperatures than the Caucasians in this investigation.

3. A follow-up study is proposed to examine the relationship of cold experience and finger temperature response to cold stress. Cold sensitivity may be related to other considerations besides ethnical or geographical background of the individual. If the factors that contribute to cold sensitivity in otherwise normal healthy individuals could be isolated, regardless of ethnic origin, procedures could be implemented to better help the individual soldier perform in cold environments.

REFERENCES

1. Adams, T. and Covino, B.G. Racial Variation to a Standardized Cold Stress. J. Appl. Physiol. 12:9-12, 1956.

2. Baker, P. T. American Negro-White Differences in the Thermal Insulative Aspects of Body Fat. Human Biol. 31:316-324, 1959.

3. Bobrov, N.I. Lomov, O.P. and Tikhomirov, V.P. Physiological and Hygienic Aspects of Human Acclimatization in the North. Leningad: Meditsina, 1979.

4. Brown, R.A., Fader, K. and Barber, T.X. Responsiveness to Pain: Stimulus-Specificity versus Generality. Psychol. Record. 23:1-7, 1973.

5. Clark, J.W. and Bindra, D. Individual Differences in Pain Thresholds. Canad. J. Physiol. 10:69-76, 1956.

6. Forgione, A.G. and Barber, T.X. A Strain Gauge Stimulator. Psychophysiol. 8:102-106, 1971.

7. Goldman, R.F., Newman, R.W., and Wilson, O. Effects of Alcohol, Hot Drinks, or Smoking on Hand and Foot Heat Loss. Acta Physiol. Scand. 87:498-506, 1973.

8. Hokanson, D.E., Sumner, D.S. and Strandness, D.E., Sr. An electrically calibrated plethysmograph for direct measurements of limb blood flow. IEEE Trans. Biomed. Eng. 22:25-29, 1975.

9. Iampietro, P.F., Goldman, R.F., Buskirk, E.R. and Bass, D.E. Response of Negro and White Males to Cold. J. Appl. Physiol. 14:798-800, 1959.

10. Jobe, J., Beetham, T., Roberts, D.E., et al. Induced vasodilation as a Home Treatment for Raynaud's Disease. J. Pneumatol. 12:953-956, 1985.

11. LeBlanc, J. and Potvin, P. Studies on Habituation to Cold Pain. Canad. J. Physiol. Pharmacol. 44:287-293, 1966.

12. Meehan, J.P. Individual and Racial Variations in a Vascular Response to a Cold Stimulus. Military Medicine 116:330-336, 1957.

13. Meehan, J.P. General Body Cooling and Hand Cooling. In: F.R. Richner (ed.) <u>Protection and Function of the Hands in Cold Climates.</u> Natl. Acad. of Sciences. National Research Council, Wash. D.C., p. 45-57, 1957.

14. Morgan, W.P. and Horstman, D.H. Psychometric correlates of pain. Perceptual Motor Skills 47:27-39, 1978.

15. Newman, R.W. Cold Acclimatization in Negro Americans. J. Appl. Physiol. 27:316-319, 1969.

16. Ohgi, S., Moore, D.J., Miles, R.D., Lambeth, A., McAllister, L. and Sumner, D.S. The Effect of Cold on Circulation in Normal and Cold Sensitive Fingers. Bruit 9:9-15, 1985.

17. Orr, K.D. and Associates. Cold Injury-Korea 1951-1952, Army Medical Research Laboratory, Ft. Knox, Kentucky, Report No. 113, 1952.

18. Ottson, D. "Pain". In: Physiology of the Nervous System., Oxford University Press, N.Y., P. 461, 1983.

19. Patton, G.W. Combined Autonomic Effects of Concurrently Applied Stressors. J. Physiol. (London) 146:152-164, 1959.

20. Peacock, J.H. A Comparative Study of the Digital Cutaneous Temperature and [Hand Blood Flows in the Normal Hand, Primary Raynaud's Disease and Primary Acrocynaous. Clin. Science 18:25-33, 1959.

21. Rennie, D.W. and Adams, T. Comparative Thermoregulatory Responses of Negro and White Persons to Acute Cold Stress. J. Appl. Physiol. 11:201-204, 1957.

22. Sampson, J.B. The Influence of Psychological Variables on the Emotional and Finger Temperature Responses to Acute Cold Exposure. Ph.D. Dissertation, Tufts University, Boston, MA, 1975.

23. Spielberger, C.D., Gorsch, R.L. and Cushene, R.E. State-Trait Anxiety Inventory. "Self-Evaluating Questionnaire". Palo Alto Consulting Press, 1970.

24. Spurr, G.B. Peripheral Circulatory Responses of Negroes and Caucasians to Local Cold Exposure as Influenced by Season. Technical Report No. 60-30, June 30, U.S. Army Research and Development Command, Wash. D.C., 1963.

25. Sumner, D.S., Criblez, T.L. and Doolittle, W.H. Host Factors in Human Frostbite. Military Medicine 141:454-461, 1974.

26. Wyndham, C.H., Ward, J.S., Strydom, N.B., et al. Physiological Reactions of Caucasian and Bantu Males in Acute Exposure to Cold. J. Appl. Physiol. 19:583-592, 1964.

Appendix 1

SELF-EVALUATION QUESTIONNAIRE

Developed by C. D. Spielberger, R. L. Gorsuch and R. Lushene

STAI FORM X-1

NAME __________________________________ DATE ____________

DIRECTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and then blacken in the appropriate circle to the right of the statement to indicate how you *feel* right now, that is, *at this moment*. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

	NOT AT ALL	SOMEWHAT	MODERATELY SO	VERY MUCH SO
1. I feel calm	1	2	3	4
2. I feel secure	1	2	3	4
3. I am tense	1	2	3	4
4. I am regretful	1	2	3	4
5. I feel at ease	1	2	3	4
6. I feel upset	1	2	3	4
7. I am presently worrying over possible misfortunes	1	2	3	4
8. I feel rested	1	2	3	4
9. I feel anxious	1	2	3	4
10. I feel comfortable	1	2	3	4
11. I feel self-confident	1	2	3	4
12. I feel nervous	1	2	3	4
13. I am jittery	1	2	3	4
14. I feel "high strung"	1	2	3	4
15. I am relaxed	1	2	3	4
16. I feel content	1	2	3	4
17. I am worried	1	2	3	4
18. I feel over-excited and "rattled"	1	2	3	4
19. I feel joyful	1	2	3	4
20. I feel pleasant	1	2	3	4

SELF-EVALUATION QUESTIONNAIRE

STAI FORM X-2

NAME ______________________________ DATE ______________

DIRECTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and then blacken in the appropriate circle to the right of the statement to indicate how you *generally* feel. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.

	ALMOST NEVER	SOMETIMES	OFTEN	ALMOST ALWAYS
21. I feel pleasant	1	2	3	4
22. I tire quickly	1	2	3	4
23. I feel like crying	1	2	3	4
24. I wish I could be as happy as others seem to be	1	2	3	4
25. I am losing out on things because I can't make up my mind soon enough	1	2	3	4
26. I feel rested	1	2	3	4
27. I am "calm, cool, and collected"	1	2	3	4
28. I feel that difficulties are piling up so that I cannot overcome them	1	2	3	4
29. I worry too much over something that really doesn't matter	1	2	3	4
30. I am happy	1	2	3	4
31. I am inclined to take things hard	1	2	3	4
32. I lack self-confidence	1	2	3	4
33. I feel secure	1	2	3	4
34. I try to avoid facing a crisis or difficulty	1	2	3	4
35. I feel blue	1	2	3	4
36. I am content	1	2	3	4
37. Some unimportant thought runs through my mind and bothers me	1	2	3	4
38. I take disappointments so keenly that I can't put them out of my mind	1	2	3	4
39. I am a steady person	1	2	3	4
40. I get in a state of tension or turmoil as I think over my recent concerns and interests	1	2	3	4

APPENDIX 2.

Classification of Cold Experience (CE)

The classification of cold experience is one in which individuals are placed into "little", "moderate" or "much" CE categories based on the amount of prior cold weather exposure or experience an individual has had. Cold experience (CE) is based on a total score taken from 6 questions of the Cold Environment Background Survey Form (see appendix 3). Questions 15, 16, 22, 23, 26 and 27 from the survey pertain particularly to the area where the individual has spent most of his life, to types (classroom instruction and field training) of cold weather exposures, to the amount of time spent in cold weather regions and to a subjective rating of how one feels about living in cold climates. Scores are derived from "weights" given to each of the multiple choice answers from questions 16, 22, 23, 26 and 27. Each question will therefore give a score of from 1 to 4 (see appendix 3). Question 15 is given a weight of 1 to 4 depending upon how long a time an individual has spent in a particular state of either zone 1, 2, 3 or 4 (see appendix 4). Those answering zone 1 are given a score of 4; for zone 2, a score of 3; for zone 3, a score of 2; and for zone 4, a score of 1. When the total score is accumulated, it will range from a minimum of 6 to a maximum of 24 points. A classification of "little" CE carries a score of 6 to 12 total points, "moderate" CE, a score of 13 to 18 total points, whereas "much" CE would fall between a total score of 19 to 24 points.

Appendix 3

Cold Environmental Background Survey Form

NAME:_________________________________DATE:__________ ____________
(Last, First, Middle Initial) (Day/Mo./Yr)

PART I: BASIC DEMOGRAPHIC INFORMATION

INSTRUCTIONS: For each of the items below FILL in the blank or CIRCLE the appropriate code number, answering each item to the best of your knowledge Please make sure you have answered every item.

1. Age:_______

2. Gender: 1. Male 2. Female

3. Race: 1. White/Caucasian
   2. Black/Negroid
   3. Other: _______________________

4. Height:_____________ (ft./in.)

5. Weight:_____________ (lbs.)

6. Marital Status: 1. Single 4. Divorced
   2. Married 5. Widow/widower
   3. Separated

7. Indicate your highest level of formal civilian education:
   1. Less than High School
   2. Some High School
   3. High School Graduate
   4. G.E.D. Credit for H.S.
   5. Some College
   6. College Graduate
   7. Some Graduate School

8. Civilian Occupation:_____________________________

9. Rank: E-_______ WO-_______ O-_______

10. Years active military service:___________________

11. Primary MOS:________________ Title:_____________________________

12. Duty MOS:__________________ Title:_____________________________

13. Duty Station: (Post/Location):__________________________________

14. Unit:____

15. Name and Location of the community in which you spent most of your life:
    __________________________________ Number of years spent there____.
    (Town/State/Nation)

16. Indicate the percentage of your life spent where during the coldest month:

____ usually didn't go below 50°F. (warm or hot all year, mild winters)

____ usually didn't go below 32°F: (warm or hot summers, cool winters)

____ usually didn't go below 14° F: (mild summers, cold winters)

____ usually went below 14° F: (mild summers, cold winters)

17. Indicate the percentage of your life spent in the following geographic location:

_____ Urban   Suburban_____   Rural_____

18. Indicate the amount of regular daily consumption:

	None	Small Amount	Moderate Amount	Large Amount	Specify # of cups/drinks per day
Caffeinated coffee or tea (without sugar)	0	1	2	3	______
Caffeinated coffee or tea (with sugar)	0	1	2	3	______
Colas	0	1	2	3	______
Other sugared soft drinks	0	1	2	3	______
Alcoholic beverages	0	1	2	3	______
Salt/Salty foods	0	1	2	3	______
Cigarettes	0	1	2	3	______
Pipes/Cigars/chews	0	1	2	3	______
Stimulant/Drug medication	0	1	2	3	______
Relaxant/Drug medication	0	1	2	3	______
Allergy/hay fever meds	0	1	2	3	______
Cold medicines	0	1	2	3	______
Other medications	0	1	2	3	______

19. How often do you take part in physical activity or sports?

1. Not at all   2.__________days per month

20. How would you compare yourself to others of your own sex and age in terms of physical ability and fitness?

1. Poor 2. Fair 3. Average 4. Above average 5. Superior

21. Describe yourself in terms of physical activity.

1. Inactive 2. Active 3. Very Active

PART II: COLD ENVIRONMENT HISTORY
(Temperatures at freezing (32° F) or below)

22. How much experience have you with freezing weather or cold climates?

1. No Experience 3. A MOderate Amount

2. A Slight Amount 4. A Great Amount

23. In general, how do (would) you feel about living in a geographical area having cold winters?

1. I (would) really enjoy it. 3. I don't (wouldn't) care for it.

2. I (would) tolerate it. 4. I (would) dislike it very much.

24. Check the activities you have done in cold weather:

____ Snow Skiing	____ Ice Fishing	____ Snowmobiling
____ Snow Shoeing	____ Ice Skating	____ Shoveling Snow
____ Making A Snowman	____ Ice Sailing	____ Other:__ ____
____ Camping	____ Snow Sledding	____ None of these

25. Compared to others around you, in a cool or cold environment, how do you generally feel?

1. Colder than others 3. Warmer than others

2. About the same as others 4. Have no idea how I differ from others in this respect

26. How much military classroom instruction have you had for taking care of yourself in cold weather?

1. No instruction 3. Warmer than others

2. A Slight Amount 4. A Great Amount

27. How much field training have you had on taking care of yourself in cold weather?

1. No Field Training
3. A Moderate Amount
2. A Slight Amount
4. A Great Amount

28. Do you have any special problem when you are exposed to cool or cold conditions?

1. No
2. Yes, specify:______________________________

____

29. How many times have you been treated by medical personnel for any of the following injuries? Please give exact number.

Frostnip______ Chilblains______ Check if none of these______

Frostbite_____ Hypothermia_____ Other:______________________

30. How many times untreated? Please give exact number.

Frostnip______ Chilblains______ Check if none of these______

Frostbite_____ Hypothermia______ Other:______________________

Appendix 4.

Categorization of States into 4 Temperature Zones

Zone 1 Cold States : (average temperature for the winter months is below 14 degrees Fahrenheit) score = 4.

Alaska, Wisconsin, Montana, North Dakota, South Dakota, Maine, Vermont, Michigan, Wyoming and Minnesota.

Zone 2 Cool States : (average temperature for the winter months is below 32 degrees Fahrenheit) score = 3.

New Hampshire, Massachusetts, Iowa, Illinois, Kansas, Idaho, Colorado, Connecticut, Nebraska, Nevada, New York and Utah.

Zone 3 Mild States : (average temperature for the winter months is below 50 degrees Fahrenheit) score = 2.

Missouri, New Jersey, Mew Mexico, Ohio, Pennsylvania, Rhode Island, District of Columbia, Kentucky, Maryland, Oklahoma, North Carolina, Virginia, Arkansas, Oregon, Tennessee, Washington, West Virginia and Delaware.

Zone 4 Warm States : (average temperature for the winter months is above 50 degrees Fahrenheit) score = 1.

Georgia, Arizona, Mississippi, South Carolina, Texas, Alabama, California, Louisiana, Florida and Hawaii.

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